Achieving a More Efficient Chemical Industry

DOE helps chemical companies maximize performance

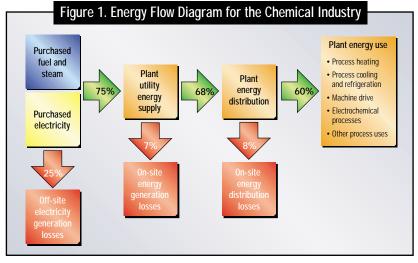
By Riyaz A. Papar, P.E., and Paul E. Scheihing, P.E.

he chemical industry is the keystone of the U.S. manufacturing sector. A rapidly changing business environment in the U.S. chemical industry highlights the need for continued global competitiveness.

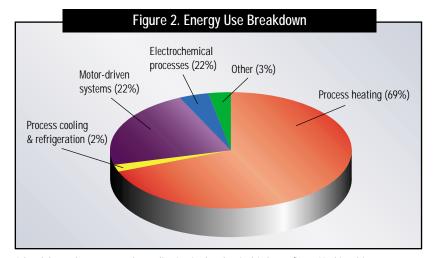
In a unique partnership, chemical industry leaders have teamed with the U.S. Department of Energy's (DOE)

Office of Industrial Technologies (OIT) to focus on innovative technologies that strengthen the industry's competitive position. Called the "Chemical Industry of the Future," the partnership promotes technologies that optimize energy efficiency in operations and reduce waste and energy-related emissions.

DOE supports this partnership by



Only 60 percent of the chemical industry's input energy is used by plants for end-use purposes.



A breakdown of energy uses by application in the chemical industry (Note: Machine-drive energy use consists mainly of motor-driven systems. Only a small portion is used for gas and steam turbine drives.)

developing high-risk, high-payoff precompetitive technologies within a 20-year planning time frame. However, DOE currently offers a range of programs that can help the chemical industry save energy, reduce costs and cut pollution right away.

DOE first focuses on making a company aware of all the potentially applicable technologies, tools and expertise in its extensive portfolio of products and services. The agency then works with the company to try to address its specific needs. This article highlights some of the resources and tools DOE offers to the chemical industry, including nearterm assistance through its BestPractices program.

Industry energy profile

Primary energy consumption. The chemical industry uses nearly 4,353 trillion British thermal units (Btus) as primary energy (not including energy associated with feedstock). Figure 1 shows the energy flow for the sector, assuming an input of 100 units of primary energy. The figure shows that only 60 percent of the input energy actually is used by chemical plants for end-use purposes; 40 percent is attributed to conversion and distribution losses.^{1,2}

Plant energy use. According to a DOE report³, the annual energy required for process heating, process cooling and refrigeration, machine drive, electrochemical and other processes amounts to 2,786 trillion Btus. Figure 2 shows the breakdown of this component by application percentage.

Energy use by motor-driven systems. A 1998 industrial market assessment⁴ from DOE provides detailed information about motor system energy consumption in the chemical industry and the potential savings opportunities that can be realized zby applying state-of-the-art and proven technologies to motor-driven systems.

Figure 3 shows the percentage breakdown of motor-driven system energy by application. Compressed air, pumps and fan systems make up almost two-thirds of motor system energy use in the sector.

Figure 4 identifies the different system efficiency measures that can reduce motor systems' energy consumption. The market assessment study⁵ predicts the chemical sector could save 23,188 GWh of motor system energy annually. This amounts to 16.1 percent of the total energy consumed by motor-driven systems. DOE uses this type of information to target BestPractices program activities to achieve the highest level of efficiency in the chemical industry and to save money.

Getting help from DOE

DOE's OIT has myriad resources and tools that can help companies become more energy-efficient, reduce environmental emissions, increase profits and boost competitiveness in global markets. A small cross-section of these resources and tools is presented below, but more detailed information can be found on the DOE Web sites listed in the sidebar.

Chemical industry team. OIT's chemical industry team works with industry, trade groups, other government agencies and the academic community to sponsor R&D activities. The team uses the goals defined in "Technology Vision 2020: The U.S. Chemical Industry"6 and the technology priorities described in the roadmaps (information and analysis about a sector's future and R&D plans, found on OIT's Web site). The expertise and guidance from industry leaders ensure the chemical R&D portfolio yields the greatest benefits for the industry while contributing to national goals for improved energy efficiency and environmental quality.

R&D portfolio. Using the roadmapping data, the industry has identified critical chemical R&D areas. Currently, OIT's chemical team portfolio includes 28 cost-shared projects. Examples of these projects include electrodeionization for product purification, oxidative cracking of hydrocarbons to ethylene, multiphase computational fluid dynamics and alloys for ethylene reactor development of nonaqueous enzymes.

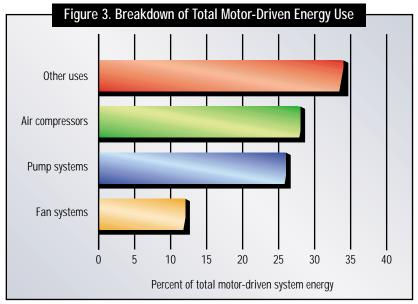
Cooperative activities. OIT participates in cooperative activities with other

organizations and associations that serve the chemical industry. One example, the Practical Minimum Energy Study, is to be done in conjunction with the American Institute of Chemical Engineers (AIChE). The study's objectives are to develop baseline energy uses for the manufacture of major chemicals and to determine the best and least energy-intensive way to manufacture those chemicals under practical operating conditions. When completed, this study will assist decision-makers in developing energy management strategies and provide a useful comparison of energy needs across the chemical industry. For more information, e-mail Joseph Rogers of AIChE at jorogers@aiche.org.

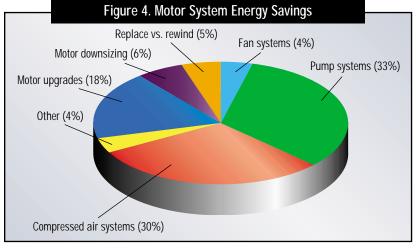
BestPractices program

The BestPractices program offers tools to improve a chemical plant's energy efficiency, enhance its environmental performance and increase its productivity. The program works to improve the system efficiency of motor, steam, compressed air and process heat systems plantwide. It includes all the resources, tools and expertise previously included in OITs' Motor Challenge, Steam Challenge, Compressed Air Initiative and Industrial Assessment Centers.

The BestPractices program is an approach that can be described as "developed by industry for industry." The overall program design evolved over several years with substantial input from the industrial



Motor-driven systems use 144,362 GWh annually in the chemical sector.



Shown are the motor system energy savings achieved through system efficiency measures at a typical chemical plant.

community. Program benefits include case studies, showcase demonstrations, decision-making software, training programs, plant assessments, technical publications and information services.

Case studies. Case studies develop information on the field performance of energy-efficient technologies and design practices. They can be used by facility managers to assess the applicability of similar measures in their own facilities. For example:

- 3M Corp. conducted an in-house motor system performance optimization project and identified four key energy-saving projects (upgrade of research pilot plant air supply, upgrade of reheat water supply system, upgrade of supply air fans and retrofit of the motors with more energy-efficient motors models). These upgrades reduced electricity use by 41 percent, resulting in an annual cost savings of \$77,500 and a reduction of 328,690 pounds of carbon equivalent emissions. 3M later incorporated these system improvements companywide and saved \$823,000 in annual energy costs.
- Velsicol's Chestertown, Md., facility implemented an improved preventive maintenance program that identified energy losses in its steam system. On a Btu-per-pound-of-production basis, Velsicol reduced annual energy consumption by 28 percent, annual fuel costs by \$80,000 and annual emissions by 2,400 tons. Additional benefits included reduction in make-up water and treatment chemicals, saving more than \$20,000 annually.

Showcase demonstrations. A showcase demonstration is a public event designed to highlight the benefits of energy efficiency and resource productivity via application in real-use conditions in a manufacturing environment. A plant partners with OIT, serving as a host site, and is eligible to receive funding for cost-shared technology implementation and plantwide energy-use assessments. In addition, OIT offers participating companies technical expertise, tools and information to enhance manufacturing operations.

Decision-making software. The fol-

lowing software is available:

- MotorMaster+: selects energyefficient motors and acts as a management tool.
- Pump System Assessment Tool (PSAT): assesses the efficiency of pumping system operations.
- ASDMaster: provides adjustablespeed drive evaluation methodology and application software (an EPRI tool).
- Steam System Scoping Tool: profiles and grades steam system operations and management.
- AirMaster: evaluates compressed air system performance.
- 3EPlus: evaluates the thickness of industrial insulation for a variety of operating conditions.

Additional Energy-savings Information

DOE'S OIT:

www.oit.doe.gov

Chemical Industry of the Future: www.oit.doe.gov/chemicals

DOE's BestPractices program: www.oit.doe.gov/bestpractices

Training. The BestPractices program offers systemwide and component-specific training programs for motor systems, pump systems, compressed air systems and steam systems. This product-neutral training helps plants run more efficiently. Workshops are offered nationwide throughout the year.

Plant assessments. Assistance for plant assessments is based on the size of the plant. For small- or medium-sized facilities, the no-cost Industrial Assessment Centers can be excellent sources for identifying energy-saving opportunities. Large facilities are invited to participate in an open solicitation for a plantwide assessment with a 50 percent cost-share up to \$100,000.

Technical publications. The Best-Practices program offers a broad selection of technical publications that discuss efficient and optimized operation of industrial systems and components. Most of these publications are

available on DOE's BestPractices Web site (see sidebar).

Information services. The BestPractices program has a staffed Information Clearinghouse (phone: [800] 862-2086) that answers technical questions and compiles and disseminates technical information on a wide variety of topics. The program also maintains a Web site (see sidebar) and a bimonthly newsletter.

Allied partnerships. Allied partners are private companies, industrial service and equipment providers, utilities and other organizations and government agencies that agree to use the BestPractices program to increase energy efficiency and productivity for their customers.

Why OIT?

DOE's OIT has a wealth of information, resources and tools for the chemical industry to increase system energy efficiency, reduce overall energy costs, reduce emissions and strategically position the industry in the global competitive market.

References

- 1. Manufacturing Consumption of Energy 1994. DOE/EIA-0512(94), December 1997.
- 2. Overview of Energy Flow for Industries in Standard Industrial Classifications 20-39. Final summary report for OIT, prepared by Arthur D. Little Inc., December 2000.
 - 3. Ibid.
- 4. United States Industrial Electric Motor Systems Market Opportunities Assessment. Final report prepared for OIT and ORNL by Xenergy Inc., December 2000.
 - 5. Ibid.
- 6. "Technology Vision 2020: The U.S. Chemical Industry." Published by the American Chemical Society, the American Institute of Chemical Engineers, the American Chemistry Council, the Council for Chemical Research and the Synthetic Organic Chemical Manufacturers Association, 2000.

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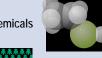
INDUSTRIES OF THE FUTURE





Aluminum







Forest Products





Metalcasting





Petroleum





Combustion







Sensors & Controls







Inventions & Innovation

Assessment Centers







While the economy and security of our nation rely on the vitality of industry, global competitiveness is key to the future of U.S. industries. The Department of Energy's Office of Industrial Technologies (OIT) is committed to helping industries accelerate progress in the twenty-first century. Through OIT's Industries of the Future program, industries can take advantage of OIT's Emerging Technologies, BestPractices and Financial Assistance opportunities in order to find solutions to tough environmental and energy challenges.

To learn more about these opportunities and many others, visit the Industries of the Future home page at www.oit.doe.gov.



OIT recently published a new report entitled Energy and Environmental Profile of the U.S. Chemical Industry. The document provides benchmark energy use and pollution emmisions data, based on several DOE, EPA and other official reports. It is an excellent reference for chemical engineers and others working in or with the chemical industry.

To order your copy, call OIT's Clearinghouse at 1-800-862-2086. Similar reports for aluminum, steel, metalcasting and petroleum refining industries are also available.